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Plant Introduction Newsletter No.5

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NOTES

1. These Newsletters represent informal communications addressed only to persons who are directly and actively interested in plant exploration, collection and introduction.

2. It is regretted that it is not possible to issue complete versions of these Newsletters in the three working languages of FAO - English, French and Spanish. As news items are, however, included in the original language the Newsletter is thus published in a trilingual form.

3. The earlier issues of this Newsletter contained reports of expeditions planned or in progress. It would be greatly appreciated if those concerned could send a report of these expeditions as soon as possible for inclusion in a later issue of the Newsletter.

4. All correspondence with regard to the above items should be addressed to the institutes or specialists concerned, or to: Dr. R.O. Whyte, Chief, Crop Production and Improvement Branch, FAO, Rome, Italy. Those wishing to be included on the mailing list for further issues of these Newsletters are requested to inform the above if they have not already done so.

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91. Problems of Collection, Maintenance and Evaluation of Wild Species of Cultivated Plants

Professor Dr. W. Rudorf
Max-Planck-Institut, Köln-Vogelsang, Germany

The introduction of seed samples of species of cultivated plants from their endemic habitats to other countries has been carried on in a primitive way since the earliest times. There is no country in which there are not cultivated species brought in from areas of their origin - often from far distant continents. It is well-known that the introduction of potato, maize, beans and other species to Europe followed the discovery of the New World in about 1500 A.D. Botanical explorations and systematic studies up to this century have led to a deeper knowledge of the flora related to cultivated plants, but it is chiefly as a result of the Russian collecting expeditions in Eurasia, Asia and the New World (Regel, Vavilov) in the first quarter of the 20th century, followed by expeditions of other countries, that a new period of research on the resources of wild and primitive species has been initiated.

In this article, questions related to the use of wild species as a source of genes for resistance to parasites and animal pests will be briefly considered. There are three chief problems:

(1) Collection,
(2) Maintenance of collections, and
(3) The evaluation of collections.

1. Problems of collection

Until now, collections have been made by scientists who organized expeditions throughout the areas of origin of the wild species. They travelled to these areas during short periods and gathered seeds, tubers, etc. in places within the habitat which were easily accessible. Much of this material was bought in the markets of the indigenous populations. These expeditions have brought to light extremely interesting material for systematic, genetical, cytogenetical and phytopathological (resistance) research. Nevertheless, these first expeditions were not able to collect representatives of the total variability of different species, as the points of collections by no means covered the total area of a given genus, and the places from which specimens were obtained were too scattered to allow a sufficiently comprehensive collection. It has been recognized that the reliable locating of gene centres depends chiefly on the density of the sites of collection.

Expeditions of short duration have another important drawback. It is well-known to specialists that the existence and time of appearance of plants of wild species in a certain locality during the growing season depend largely on the time of the rainy season and other factors. This applies particularly to the dry regions of the Andean countries. Thus it may well

happen that in one year with an abnormal period of rainfall a certain species is not found in a place where it was located a year before.

In recent years scientists of those countries where gene centres are located have done successful work in the exploration of wild species. In South America Burkart, Cardenas, Ochoa, Parodi, Vargas and others have made very fine contributions and have been most helpful to various expeditions because of the fact that they live permanently in those regions. It should be mentioned that the very successful activity of Hawkes as a collector and systematist is due to a great extent to his long stay in Colombia.

The first conclusion to be drawn from the above observations is that the collection of wild species cannot be efficiently done during the expeditions by scientists who go only for a short time to the areas of gene centres, but that plant collecting is a permanent task. Foreign scientists should work for at least two years in those areas in which they would like to collect, and national scientists of the countries involved should be given opportunities to co-operate intensively in collections.

There are other important aspects of plant collecting which make it an urgent matter to consider it as a permanent objective. Ecological studies within the regions and even in sites where species and their sub-units occur cannot be made thoroughly without an adequate study of plant associations and climatic and edaphic conditions. It is a propitious moment to call attention to such fundamental studies, as we are commemorating the very important activity of Alexander von Humboldt in this domain a hundred years ago. It is clear that such studies would permit a more thorough knowledge of species and their varieties both from the general botanical standpoint, and also from that of plant breeding.

Closely connected with these studies are those on phytopathological conditions in regions and sites where certain genera, species and their sub-units occur. Wild species offer important gene resources for resistance to all kind of parasites. The selection for resistance in the natural habitat is of decisive importance for the evaluation of species and their components, as it is well-known that it is not a species as a whole which bears genes for resistance, but only single lines or families within it. Their detection in the endemic regions and sites will guarantee a much more effective evaluation than was possible when the discovery of resistant forms was largely accidental. In this connection, it should be realized that very often - if not generally - the habitat of the gene centre of species of cultivated plants is also the habitat of the parasites - fungous, bacterial, virus and animal - which affect their growth and health. There are definite biocoenoses of host plants and the organisms living on them. Though these relations must be studied in each case, the principles of such associations are convincing from the biological point of view. The chief parasites and pests of the potato, for example, (late blight, early blight, virus, scab, cancer, nematode), are

to be found in the endemic habitat of potato species in South America, Mexico and other countries of Central America.

We can even formulate the hypothesis that the parasitic organisms have their "gene centres", the regions of most intensive specialization in common with species related to cultivated plants. This, of course, does not exclude the possibility that in countries remote from the gene centres, where the cultivation of certain species has begun, new parasites appear which are not known in the original regions of these species. Nevertheless the fact remains that natural selection for resistance within the endemic area is of greatest importance, which explains the fact that the occurrence and frequency of genes for resistance is closely connected with the habitat of origin of a species.

Two contradictory phenomena must be considered. It is not the species as an entity which is resistant, as might be expected, if resistance is the outcome of natural selection. However, we must remember that wild species, in contrast to the cultivated ones, possess organs, e.g. the stolons in wild species of the potato, which enable them to escape from an annihilating epiphytic.

Further, we may find genes for resistance to parasites and pests which do not occur in the endemic area of a species, for example, the resistance to Colorado beetle in the Commersoniana group of Solanum. Nevertheless, for two reasons the "covariance" of species of origin or of related species of cultivated plants and their parasites - when compared - may be important: (a) in plant collecting, selection for resistance should be done at the same time; (b) one might expect to find forms of wild species with "group resistance" to many physiological races, or another type of resistance which manifests itself independently from physiologic specialization ("field resistance", "incubation resistance", or "generalized type of resistance").

2. Problems of maintenance of collections

To those acquainted with the relevant problems, it is well-known that, when wild species are transferred to distant regions with very different light and temperature conditions, the maintenance of complete collections becomes very difficult, if not impossible. This is true for all species with pronounced photoperiodic, thermal and thermo-periodic reactions. As a result, many forms in a collection may be lost within a short time. On the other hand, it would be easy to maintain all the collected species and their subunits at appropriate places within the gene centre, their original habitat.

3. Problems of evaluation of collections

This should be done - as indicated by the above arguments - within the regions of origin of a genus. This evaluation should include systematic and genetical (cytogenetical) studies, as well as phyto-pathological studies and the search for resistance. This concentration of research in institutions located at appropriate places within the gene centres does not preclude the introduction of species and their sub-units to countries where they would be included as "gene stocks" in breeding programs, involving all those studies relating to the successful transfer of new desirable genes into varieties of cultivated plants.

Conclusion

Collection, maintenance and evaluation of wild species and primitive forms should be made the object of international co-operation. The three types of research noted are permanent objectives which can best be effected in institutes within the regions of the gene centres, where scientists from countries within those areas can co-operate with scientists of countries interested in the introduction of wild species and primitive forms as sources of valuable genes for resistance to parasites, climatic factors, and so on.

The best or at least a satisfactory form of international organization for such co-operation should be devised. Special consideration should be given to existing institutions. We call to your attention the Inter-american Institutes in Mexico, Colombia, Peru, Bolivia and elsewhere, organized and maintained by the Rockefeller Foundation. FAO, as the agricultural agency of the United Nations, could perhaps take the lead in organizing this important international co-operation.

The author had the opportunity to study these problems during a trip to Mexico, Peru, Bolivia and northwest Argentina in 1958. He is indebted for many valuable suggestions to Dr. John Niederhauser (Mexico), to Dr. M. Cardenas and other technicians of the countries visited, and to Dr. E.C. Stakman (St. Paul, Minnesota, USA). On the basis of 35 years of experience of research on the evaluation of wild species and primitive forms in breeding programs, the author feels justified in submitting these ideas for general discussion and as a basis for future planning.

92. The Birmingham University Plant Collecting Expedition to Mexico and Central America

Dr. J.G. Hawkes
Senior Lecturer in Taxonomy, Department of Botany

"The houses of the Indians were all supplied with maize, beans and potatoes, rounded tubers which are planted and which produce a stem with branches and leaves, and occasionally some pale purple flowers, and the roots of this said plant, which is two feet high, are produced under the earth, about the size of an egg, some round and others elongated; they are white, purple or yellow, floury roots of good flavour, a very acceptable gift for the Indians and a delicacy even for the Spaniards."

Juan de Castellanos: Historia del Nuevo Reino de Granada. Written ca. 1570-1601. Published Madrid, 1886.

Thus wrote the sixteenth-century chronicler of one phase of the Spanish conquest of the New World, and since his time this plant, the potato, which was previously unknown in Europe, has become a staple article of diet far beyond its original home. Yet the more widespread and the more uniform a food plant becomes, the easier it is for disease to spread through it. The history of the potato bears this out. Innumerable varieties were bred from only a few plants brought from South America, all rather similar to each other and all highly susceptible to disease.

By the mid-nineteenth century, when the potato had taken its place as a European food crop, farmers and scientists were saying that it needed "new blood" from the wild forms in its original home to "rejuvenate" it. Hardier, more resistant stocks were needed to prevent a recurrence of such disasters as the Irish potato famine of the 1840s.

This seemed simple enough, but many difficulties arose when attempts were made to collect the original wild potato and hybridise it with our domestic varieties. Instead of one ancestral wild species in South America, it was found eventually that about 120 wild and eight cultivated species existed. Early attempts at using wild species in crossing with our domestic varieties made use of ones that were not particularly disease resistant, were not closely related to the cultivated forms and did not cross easily with them. Indeed, we know very little about the wild and primitive cultivated potatoes of South America from the point of view of disease resistance until about thirty years ago.

We know now that the Indians of South America cultivated potatoes in their remote mountain valleys many centuries before Europeans came there. Wild potatoes had spread over a very large area, from Colorado in the USA to the region of Chiloé in southern Chile. They have been found in the pampas of Argentina, Uruguay and Brazil, and in the high mountain peaks at

altitudes of 14,000 ft. in Peru and Bolivia. Resistance to different diseases has been found in various species and is sometimes localised in certain well-defined areas, though frequently there seems to be no regular distribution pattern at all. Many collecting expeditions were needed to help us build up a picture of the geographical pattern in which genes conferring disease resistance are found. We know, for example, that the best area for resistance to late blight (Phytophthora infestans) is Mexico; resistance to insect-transmitted viruses was found to be localised in Mexico and the south-west USA on the one hand and Argentina on the other. But resistance to non-insect-transmitted viruses was found to be scattered apparently at random in many different species and in all kinds of regions.

From the potato breeder's point of view Mexico is of great importance, and several collectors have sent back living material for testing at plant breeding stations in Europe and elsewhere. Despite this, our interest in the potatoes of that country is by no means exhausted, since a number of species have not been fully investigated, while others have remained almost unknown. Adequate collections had not been made in the south-western USA nor to the south of Mexico in the Central American isthmus, before our expedition.

Mexico and the adjacent regions are also of considerable interest to the botanist as well as the plant breeder. Studies on the abilities of species to hybridise together showed that in Mexico there were several that would not cross with our cultivated potato at all, and for this and other reasons seemed to be only distantly related to it. This view has recently been confirmed by the results of biochemical (serological) and chromosome studies. It seems likely that wild potatoes (in contrast to cultivated ones) originated in what is now Mexico, and that the remnants of very primitive groups are still to be found there. Some species migrated into South America before the end of the Eocene Age and evolved independently from Oligocene to Pliocene times, when North and South America were separated from each other. Finally, the land bridge was restored in the Pliocene and some species remigrated from south to north over the Central American isthmus. Here they formed natural hybrids with the species that had remained behind. These more recently formed hybrid species possess a larger number of chromosomes than their parents, and some of them have already been used by the plant breeder with considerable success in crosses with cultivated varieties to produce new blight-resistant sorts.

The above account of potato species evolution is to a large extent a hypothesis, which fits the known facts fairly well. Nevertheless, there are gaps in our knowledge, due principally to the lack of material available in the living state for botanical and cytogenetical research. The Birmingham University Plant Collecting Expedition was designed to try to remedy these gaps by means of detailed collections and observations of the wild species growing in their natural habitats. In addition, we were particularly

anxious to have material from Central America to see whether any of it represented relics of the ancient migrations of species from Mexico into South America and vice versa.

Plans for the Expedition began in the spring of 1957, some eighteen months before the date of departure. Both the Vice-Chancellor and the late Professor Maskell took a keen interest in this project, and I was given a generous grant from the University Research and Expeditions Fund. Money was also donated by the Royal Society, the Percy Sladen Trust, the Agricultural Research Council, and by plant breeding institutes both in this country and abroad.

By making use of the long vacation, the Christmas vacation, and leave of absence allowed me for the autumn term I was able to stretch the expedition to a period of six months, from July to December inclusive. Since the outward and return journeys total about six weeks, when one has to travel with heavy luggage, no shorter period would have been economical.

An essential item for an expedition of this sort was a strong vehicle. I finally decided on a Jeep station wagon, which I bought in Denver, Colorado, and planned to motor down through Mexico, Guatemala, Honduras and Nicaragua, selling it in the last-named country at the end of the expedition. In fact, I finally sold it in Guatemala, since the market for used cars was very good there, and the local currency can be changed into dollars without restriction. We motored some 12,000 miles in this Jeep without any trouble, and probably covered several hundred more on foot. The total distance travelled, including the journeys out and back, was something in the region of 25,000 miles.

Expeditions frequently tend to stretch beyond the time limits planned for them. Since we had a strictly limited time available I had to make a rigid timetable beforehand. We got behind our schedule badly at times, but its presence was an incentive to put on speed in other places wherever it was possible.

We were a party of three. One of my two assistants was a recently graduated botanist from this University, Richard Lester, who is now working with me for three years on the material we collected. The other was a Danish botanist, Peter Hjerting, who had collected plants for many years in Argentina and had had considerable experience with wild potatoes.

Leaving by boat from Southampton on 9th July, 1958, we arrived at New York on 16th July and continued by train to Denver. We started from Denver on 25th July in the Jeep, pulling a small trailer and heading south through Colorado, New Mexico and Arizona. We entered Mexico at El Paso (Texas) after about three weeks in the United States. We spent two and a half months in Mexico and one month in Guatemala. We continued by plane to

Honduras and Nicaragua, spending only about ten days in each of these small republics and receiving generous help with local transport from the United Fruit Company and FAO scientists working in those areas. Finally we flew from Nicaragua to Jamaica, where we embarked for England, arriving in Plymouth on 4th January, 1959.

The preliminary results of the expedition are most promising, though it will of course not be possible to make a final assessment until several years' work on the material have been accomplished. We made 238 collections of potatoes, belonging to 26 different species, and were able to make a number of collections of each species from different parts of its range so as to be able to assess much more thoroughly its botanical and genetical variability. Five species were collected for the first time in the living state, and it seems probable that we have two completely new ones, as yet undescribed. For each collection we tried to dig up at least 50-60 tubers, since we had to distribute a portion to two plant breeding stations in Great Britain and to similar institutions in Germany, Sweden, Holland, Denmark and the USA. Thus eight sets of small tubers had to be separated from every sample, and at intervals these were packaged up and sent back by air mail. Field notes and progress reports also had to be typed and sent out, thus making the amount of clerical work in connection with the expedition not inconsiderable.

Besides potatoes we made 90 collections of cacti for the botanic gardens at Kew, Copenhagen and Birmingham and 450 collections of seeds, bulbs, cuttings, orchid tubers, etc., also for the same gardens. These were collected for general botanical and horticultural interest, and it is hoped that at least some of them may not have been grown before and may be valuable for ornamental purposes.

We also made 400 collections of dried plants from certain areas, chiefly in Central America, at the request of the Herbaria of Kew, British Museum, Copenhagen, Stockholm and Chicago. Seeds of beans, sweet peppers and tomatoes were obtained for certain plant breeding stations and seeds from certain families and genera for biochemical analysis in Denmark and the United States.

The total number of collections made was over 1,100, and since up to eight duplicates were made of each sample and most material had to be carefully dried and packed, sorted and registered, we had little time for relaxation or sightseeing. Our daily average of motoring was about 100 miles for the entire period, exclusive of the journeys out and back. We used all the available daylight for collecting and travelling, and most of the evenings for sorting and arranging our material. Sundays were treated as any other day, so that a seven-day week was the general rule. Despite this hard, but very enjoyable, work we kept very fit; apart from a few slight attacks of dysentery none of us suffered from any illness.

Physical dangers were, on the whole, few; rattlesnakes and fierce mongrel dogs were occasional hazards, but luckily none of us was bitten. Probably the worst dangers were the narrow winding mountain roads, often with cliffs above and precipices below. On such a road, where there is width for only one vehicle, the smaller must reverse to a passing point when two come from opposite directions. At other times there is room to pass, only with the outer wheels on the very edge of the road; one edges past the other vehicle, generally a wide bus or lorry, with only centimetres to spare.

Road surfaces were very good in Mexico and the United States, provided one kept to the main highways. Attempts to travel along what were marked on the maps as dry-weather tracks often ended in disaster. The rains were very heavy indeed in Mexico during the summer of 1958, and on several occasions we became stuck in the mud and had to wait for a lorry to pull us out.

Everywhere we met with unfailing kindness and courtesy, not only from scientists and government officials, but also from peasants and farm workers. Since many wild potatoes invade cultivated fields as weeds, the friendliness of the owners of these fields is a very important factor in obtaining good collections. The help of scientists and officials is no less necessary; in many cases they accompanied us on our trips, helped us to look for and dig potatoes and other plants, to obtain customs permits and to send postal packets out of the country. We were also given laboratory and office space when we needed it in which to sort out and dry our material.

We now have several years ahead of us with the less spectacular part of the project, in evaluating the material collected. There are no doubts at all in my mind that the expedition itself was a complete success, and I should like to take this opportunity of thanking all those in the University who gave it their help and support.

(Reprinted by permission from University of Birmingham Gazette, Vol. II, No. 5, 8 May 1959.)

93. U.S.A.: American Association for the Advancement of Science

It is tentatively proposed to hold a symposium in Section O - Agriculture at the 1959 Annual Meeting in Chicago, Ill., 28/31 December 1959, under the joint title of "Germ plasm resources in agriculture: Development and protection" The tentative outline of the programme includes some four or five 30-minute papers by recognized authorities on plant and animal germ plasm, under the following sessions:-

I. Origin of germ plasm

II. Need for and utilization of additional sources of germ plasm

III. Developmental programs in crops and livestock

IV. New approaches to plant and animal improvement

V. Perpetuation and protection of breeding stocks

94. U.S.A.: Search for medicinal plants

"Around the world, from alpine heights to sluggish deltas, and even down into the coralline depths of the Pacific, legmen for U.S. medicine were busy last week in a single-minded search. The objective: folk remedies, plants, lichens or marine slimes that might, through modern chemical analysis, yield useful drugs for treating man's ills, from toothache to cancer. In some regions, notably South America and Africa, the herb hunters were all over. Led by Dr. John Wurdack, the New York Botanical garden's Expedition No.21 was at the headwaters of the Orinoco. Seeking new or rare plants, its professional botanists were especially alert for any with medicinal promise. On five continents, 750 physicians and other medical people at 170 Seventh-day Adventist hospitals and clinics run by California's College of Medical Evangelists were collecting plants, getting patients to bring in samples of folk remedies, sometimes peering over the shoulders of witch doctors to see what went into their brews. ..... In the hope that it would turn up marketable items, New York's Sterling Drug Inc. had just underwritten the four-year program for $240,000. Virtually all major U.S. drug companies had herb hunters afield, either directly employed or under contract. ....

"The stakes in the herb hunt are high: for the scientist, the possibility of such fame as came to Penicillin Discoverer Fleming; for the company that gets a year's jump on its competitors with a widely useful product, $2,000,000 or $3,000,000 in profit - a hundred times more for a breakthrough against major forms of cancer; for mankind in general, cheaper and more effective drugs for many ills, and always the hope of victory over a still-defiant killer or crippler."

(Extract from "Time", 15 June 1959)

95. Iran: Collections by FAO Field Officer, H. Pabot

Mr. H. Pabot is now working in the Zagros Mountains, in the catchment area of the rivers which flow into the Khuzistan Development Project. He recently provided some preliminary information on certain apparently promising natural species found in this region up to 900 m. (Report of May 1959):-

Andropogon hirtus	Very common on stony hillsides; rainfall 200 to 500 mm.
Cymbopogon laniger	Less frequent but locally dominant on soils with developed profile; 300 to 500 mm. rainfall.
Aristida plumosa	Localized on soils which are more or less sandy or gypseous; fairly frequent with rainfall of 300 mm. or more; variety apparently different from that of North Africa.
Onobrychis pinnata	Intense reproduction.
Lotus (new species)	Very green; flowering in May.

96. Australia: Plant Introduction Section, Division of Plant Industry, C.S.I.R.O., Canberra

The following publications have recently been received:-

Quarterly list of introductions No.54 (Inventory of plants introduced during the quarter ended 30th September 1958)
Quarterly list of introductions No.55 (Inventory of plants introduced during the quarter ended 31st December 1958)

97. South Pacific Commission: Plant Collection and Introduction Newsletter No.3.

The following is an adaptation of the contents of Plant Collection and Introduction Newsletter No.3 of this Commission, prepared by Dr. J. Barrau, Plant Introduction Officer, and circulated to the members of the South Pacific Commission Advisory Committee on Plant Collection and Introduction:-

Attached to this letter, Members of the Committee received a copy of the plant introduction list No.6 issued by the Department of Agriculture, Fiji. Part of the plant material listed has been introduced in the scope of the South Pacific Commission plant introduction programme.

As mentioned in the previous Newsletter (No.2), the SPC Plant Introduction Officer has visited Guam and the Trust Territory of the Pacific Islands, from February 10 to mid-April last. A report of this tour is now being prepared under the title "A Preliminary Survey into the Field of Economic Botany in Micronesia". During this visit, the Department of Agriculture of the Trust Territory of the Pacific Islands requested the assistance of the South Pacific Commission in the introduction of several species of cash crops (cacao, Malayan dwarf coconut), food plants (suitable for atolls and/or for high islands, including a collection of Polynesian breadfruit varieties), legumes suitable for ground cover and green manuring, timber trees, etc.

In the field of plant exploration, the research on breadfruit varieties has been furthered in the Micronesian islands where a large amount of data and botanical specimens has been collected.

The assistance of the South Pacific Commission plant introduction service has been sought by the U.S. Department of Agriculture and the United Fruit Company in the form of technical information for the preparation of a plant exploration expedition which is now planned in the South Pacific Islands by these two organizations to collect wild and cultivated species and varieties of bananas. Plant material of an endemic species of wild banana, Musa tikap, found in Ponape Island, Carolines Group, has been collected by the Plant Introduction Officer and sent to the Imperial College of Tropical Agriculture, Trinidad, via the Kew Royal Botanic Gardens. This follows several shipments of other wild bananas from the South Pacific islands. This material will be used for the genetical studies on bananas undertaken in I.C.T.A., Trinidad.

Moreover, the SPC Plant Introduction Service continues to co-operate with FAO in a survey of coconut varieties, and with the New Crops Research Branch of the U.S. Department of Agriculture in another survey of cultivated coffee species and varieties.

Mr. J.H.A. Coenen, a graduate of the Deventer State College of Tropical and Sub-Tropical Agriculture, has been appointed Assistant to the Plant Introduction Officer. Formerly an agricultural adviser sent by FAO to Israel and other countries of the Middle East, Mr Coenen has also been stationed in Netherlands New Guinea. He is expected to arrive at the SPC Headquarters in July next.